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Xcel Energy
ENERGY STAR Retail Products Platform (ESRPP) Planning Support

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FINAL REPORT

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This report documents the analysis conducted by EMI Consulting for Xcel Energy in support of its ENERGY STAR Retail Products Platform (ESRPP) program. Our project approach, driven by the needs of Xcel Energy, has four key elements, each aimed at providing program staff with the information they need to make informed decisions about how best to administer the program.

Project Scope:
2017-2018

Tasks Performed

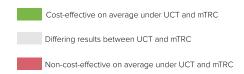| Technical assumption review | Development of baseline sales estimates | Monte Carlo simulation to assess cost-effectiveness potential | Development of a simplified logic model and set of key performance indicators |

Market Simulations

Overall, most product categories either have significant prospects for being cost-effective or limited risk of causing significant portfolio risk. The results are quite similar between the UCT and the modified TRC in terms of whether a product group is likely to be cost effective, with products more cost-effective under the modified TRC than under the UCT when they disagreed.

We used variation in the sales data, the measurement uncertainty in sales increase rates, and empirically-based scenarios of program effects over time to conduct the Monte Carlo simulation of the distribution of outcomes. Scenarios were simulated over a million times to investigate whether product groups were likely to cost-effect.

The figure to the right shows the average outcomes, with green indicating positive net benefits, red indicating negative net benefits, and gray indicating a disagreement between the utility cost test and the modified total resource cost test. Two scenarios were modeled: a 'high' scenario where costs decline rapidly and sales increases are large, and a 'low' scenario where costs do not decline and sales increases are small. The results show significant opportunities for air cleaners, clothes washers, and clothes dryers; challenges for freezers; and risks for sound bars.

- ■ Cost-effective on average under UCT and mTRC
- ■ Differing results between UCT and mTRC
- ■ Non-cost-effective on average under UCT and mTRC

Summary of Modified TRC Results by Product Category, State, and Scenario

		Low		High	
		CO	MN	CO	MN
Air Cleaners	A	$48k	$33k	$74k	$46k
	B	$66k	$33k	$114k	$50k
Clothes Washers	A	$2.0M	$1.8M	$2.8M	$1.7M
	B	$1.0M	$596k	$1.0M	$891k
Clothes Dryes (electric)	A	$1.3M	$363k	$1.2M	$339k
	B	$2.3M	$772k	$2.2M	$767k
Clothes Dryers (gas)	A	$318k	$166k	$293k	$153k
	B	$819k	$493k	$790k	$477k
Freezers	A	($6k)	($12k)	($3k)	($4k)
	B	($5k)	($12k)	($2k)	($4k)
Refrigerators	A	$752k	$390k	$691k	$386k
Room ACs	B	$75k	$15k	$81k	$22k
Soundbars	A	$5k	($6k)	$7k	($2k)
	B	($1k)	($6k)	$2k	($2k)

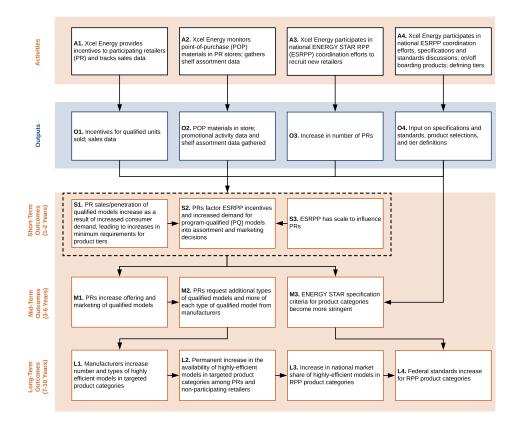*Note: Values in boxes represent modified TRC net benefits.*

Xcel Energy ESRPP Planning Support Executive Summary

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EMI Consulting also developed a simplified logic model and key performance indicators to support ongoing communication with internal and external stakeholders and program monitoring.

Simplifed Xcel Energy ESRPP Logic Model

Activities	**A1.** Xcel Energy provides incentives to participating retailers (PR) and tracks sales data / **A2.** Xcel Energy monitors point-of-purchase (POP) materials in PR stores; gathers shelf assortment data / **A3.** Xcel Energy participates in national ENERGY STAR RPP (ESRPP) coordination efforts to recruit new retailers / **A4.** Xcel Energy participates in national ESRPP coordination efforts, specifications and standards discussions; on/off boarding products; defining tiers
Outputs	**O1.** Incentives for qualified units sold; sales data / **O2.** POP materials in store; promotional activity data and shelf assortment data gathered / **O3.** Increase in number of PRs / **O4.** Input on specifications and standards, product selections, and tier definitions
Short-Term Outcomes (1-2 Years)	**S1.** PR sales/penetration of qualified models increase as a result of increased consumer demand, leading to increases in minimum requirements for product tiers / **S2.** PRs factor ESRPP incentives and increased demand for program-qualified (PQ) models into assortment and marketing decisions / **S3.** ESRPP has scale to influence PRs
Mid-Term Outcomes (3-6 Years)	**M1.** PRs increase offering and marketing of qualified models / **M2.** PRs request additional types of qualified models and more of each type of qualified model from manufacturers / **M3.** ENERGY STAR specification criteria for product categories become more stringent
Long-Term Outcomes (7-10 Years)	**L1.** Manufacturers increase number and types of highly efficient models in targeted product categories / **L2.** Permanent increase in the availability of highly-efficient models in targeted product categories among PRs and non-participating retailers / **L3.** Increase in national market share of highly-efficient models in RPP product categories / **L4.** Federal standards increase for RPP product categories

Key Performance Indicators

PPI:
Program performance indicator

MTI:
Market transformation indicator

KPI-1	KPI-2	KPI-3	KPI-4	KPI-5	KPI-6	KPI-7
PPI	PPI	PPI	PPI	PPI	MTI	MTI
Total deemed savings	Net benefit per program $ spent	Number of store visits where POP materials are placed	Number of store visits where Xcel field staff provide staff training	Number of store visits where retailer promotional activity is detected	Program-qualified sales share (PQS)	Program-qualified model assortment share

Recommendations

Based on our analysis, we make the following recommendations:

Recommendation 1:   **Consider claiming net savings based on the sales above the baseline levels determined by this research rather than applying a net-to-gross ratio.**

Recommendation 2:   **Consider adopting the updated program assumptions resulting from our review of the current technical assumptions.**

Recommendation 3:   **Consider both the potential benefits and the potential risks in determining which product groups to include in ESRPP.**

Recommendation 4:   **Consider conducting an embedded evaluation of ESRPP to support the transition from resource acquisition to market transformation.**

1. INTRODUCTION

This report documents the analysis conducted by EMI Consulting for Xcel Energy in support of its ENERGY STAR Retail Products Platform (ESRPP) program.[1,2] Our project approach, driven by Xcel Energy-specific context described below, has four key elements, each aimed at providing program staff with the information they need to make informed decisions about how best to administer the program:

1. Reviewing the program assumptions used by Xcel Energy
2. Developing baseline sales estimates of qualified products by state and tier
3. Performing a Monte Carlo simulation to assess the potential for cost-effectiveness of qualified product groups, by state and product tier
4. Developing a simplified logic model and a set of key performance indicators (KPIs) that program staff can communicate to internal and external program stakeholders

The goal of these elements is to leverage Xcel Energy's existing resources to provide tools to help Xcel Energy staff make decisions regarding whether and how to file ESRPP within its Minnesota and Colorado portfolio, which products to include in its program, and what assumptions to use in its planning and savings claims.

The remainder of this chapter provides background information on the project, including describing the national context of the program, the program theory, and the Xcel Energy-specific context. Chapter 2 describes the background review conducted by EMI Consulting, including a review of program assumptions and a quality assurance review of the program's sales data portal. Chapter 3 describes the sales baseline, including the modeling used to define the baseline and the short-term baseline sales quantities. Chapter 4 provides the results of the Monte Carlo analysis we performed to assess the prospects for cost-effectiveness. The results in the report are high-level and meant to supplement the analysis tool and dataset that EMI Consulting is providing to Xcel Energy to be able to conduct additional customized scenario analyses. Chapter 5 details the simplified logic model and key performance indicators EMI Consulting developed for the program. Finally, Chapter 6 provides a summary and recommendations.

1.1   National ESRPP Program Context

The ESRPP Program uses a nationally-coordinated, mid-stream design aimed at influencing retailers to alter their assortment (i.e., the variety of models offered for sale) and to sell, promote, and demand more energy efficient models of home appliances and consumer electronics in targeted product categories. Utilities and organizations ("Program Sponsors") across the U.S. have partnered to develop and implement ESRPP. Each participating Program Sponsor pays participating retailers per-unit incentives for every program-qualified unit that they sell in targeted product categories (e.g., clothes dryers, sound bars) during the program period. Within each product category, program-qualified models are divided into basic and advanced tiers based on efficiency level. The models in

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[1] Throughout this report, we use the word "program" in reference to ESRPP in order to avoid confusion with the qualified product groups that are supported by ESRPP.
[2] Naming of specific ESRPP programs varies by program sponsors, with some referring to them as ESRPP and some as RPP. Throughout this report we use ESRPP to refer to both national efforts and Xcel Energy's program, but use RPP to refer to specific programs that use that name, such Consolidated Edison's program.

the basic tiers are typically ones that meet the minimum ENERGY STAR specification; advanced tiers consist of more efficient models for which retailers receive higher per-unit incentives. The program theory holds that by increasing the sales of energy-efficient models over less efficient models, **the ESRPP Program will generate energy and demand savings for utility customers in the short-, mid-, and long-term through participating retailers, while also transforming the overall market towards higher efficiency in the long-term.**

Starting in March 2016, the ESRPP Program became a national effort under the auspices of ENERGY STAR. Currently, the participating retailers are Best Buy, The Home Depot, Sears/Kmart, Nationwide, and Lowe's. Current Program Sponsors include Xcel Energy (Colorado and Minnesota), the Northwest Energy Efficiency Alliance (NEEA), Pacific Gas and Electric (PG&E), Con Edison, Sacramento Municipal Utility District (SMUD), Focus on Energy (Wisconsin), Efficiency Vermont, Platte River Power Authority (Colorado), DTE Energy, EmPower Maryland, Eversource, and United Illuminating. The program intent is to enlist additional Program Sponsors over time. The most recent estimate from ENERGY STAR (from December 2016) is that the program covers roughly 18% of the total U.S. residential population and involves retailers that account for over 80% of the U.S. appliance market.[3]

The ESRPP Program is intended to keep program implementation consistent across all Program Sponsors. The evaluation team believes this serves three main purposes: (1) minimizing implementation challenges at the national level (e.g., product selection, data processing, assessing potential, retailer recruitment, etc.), (2) building a consistent and recognizable "brand" for the ESRPP Program, and (3) simplifying decision-making and implementation for the participating retailers. The targeted product categories and the qualifying efficiency levels are generally the same across Sponsors.[4]

For the 2016 national ESRPP Program cycle (March 2016 through March 2017),[5] Sponsors of the ESRPP Program incented five product categories:

- air cleaners
- electric and gas clothes dryers
- freezers
- room air conditioners, and
- sound bars.

For the 2017 program cycle (April 2017 through March 2018), two additional product categories were added to the program:

- clothes washers, and
- refrigerators.

Dehumidifiers were added in April 2018.

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[3] https://www.energystar.gov/ESRPP
[4] Some Sponsors adjust qualifying efficiency or incentive level amounts based on regional market conditions or because the incentives are not cost-effective.
[5] The national program cycles run from April through March, though the first-year cycle started in March 2016; new retailers or Program Sponsors can join at any time.

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1.2 Program Theory

The Xcel Energy ESRPP Program is aimed at market transformation in Colorado, Minnesota, *and beyond* through a mid-stream intervention strategy and engagement with both voluntary and mandatory codes and standards. The Xcel Energy ESRPP Program is one implementation of the larger (national) ESRPP program, and therefore shares the same underlying core program theory.[6] The core features of this program theory include the following sets of outcomes:

- In the short-term, the program should gain sufficient scale to influence participating retailers, leading them to consider these incentives in their stocking and assortment decisions. At the same time, program delivery will be improved through the use of sales data and other information tracked by program staff.

- In the mid-term, participating retailers should increase the proportion of qualified products in their assortment, begin to request more qualifying models from manufacturers, and favor program-qualified models in their marketing efforts. Program theory also suggests that criteria for ENERGY STAR-qualifying products will increase.

- In the long-term, manufacturers should be motivated to design to ENERGY STAR specifications and, in turn, increase the number of ENERGY STAR models offered in targeted product categories. Along with this, it is expected federal standards for these product categories will increase.

Figure 1-1 (below) depicts a generic logic model for the national ESRPP program.

EMI Consulting created a new logic model to more accurately represent the Xcel Energy ESRPP Program in a simplified form to facilitate discussion with Xcel Energy and external stakeholders. This Xcel Energy-specific logic model is discussed in Chapter 5.

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[6] The core program elements underlying different implementations of the program are the same, though some of the specifics may vary by sponsor.

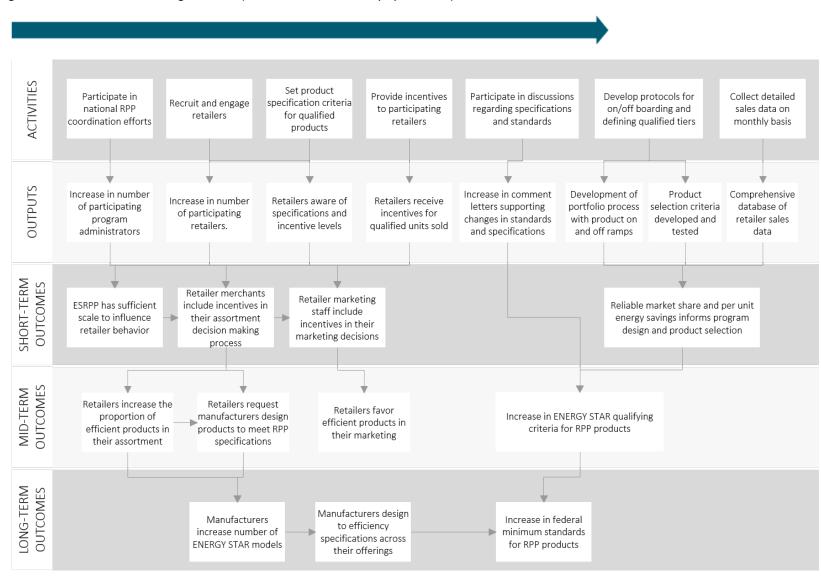**Figure 1-1. Generic ESRPP Logic Model (from SEE Action Whitepaper, 2017)**

1.3   Xcel ESRPP Program Context

Xcel Energy has its own specific context as an ESRPP program administrator determining its on-going engagement with the program. Although Xcel Energy has been running ESRPP as a pilot in Colorado and Minnesota, the utility has filed the program as a market transformation program in Colorado and is in the process of deciding how to file the program in Minnesota in its upcoming program filing.

In determining the role that ESRPP can play in its portfolio, there are several key considerations. First, Xcel Energy is facing increased energy efficiency program compliance goals at the same time that savings from traditional, easy to access measures such as lighting—long a staple of energy efficiency programs are becoming harder and more expensive to capture. Second, as the overall energy efficiency industry changes, there is greater pressure on utilities to provide energy efficiency programs that transform markets rather than just increase the prevalence of energy-efficient equipment. ESRPP is one of the prime example. Unfortunately, regulatory frameworks are typically designed to accommodate resource acquisition programs, rather than the market transformation programs, and there are no clear regulatory guidelines on how utilities should (1) claim savings for such long-term efforts, and (2) balance the short- and long-term cost-effectiveness of the programs in a portfolio. In addition, in Colorado Xcel Energy must treat rebates paid to retailers as program costs, rather than transfers, thereby greatly increasing the program costs for ESRPP.

Xcel Energy also faces regulatory concerns associated with its ESRPP efforts. The midstream incentives paid to retailers may be seen as directing large sums of money to large corporations that could instead be paid to provide incentives directly to their customers. The optics may be perceived as a potential public relations issue. And because ESRPP relies on a market transformation approach that is expected to produce limited benefits in the short term but large benefits in the long term (reflecting a very different approach than traditional resource acquisition programs), ESRPP staff have a challenge in explaining the program to decision-makers within Xcel Energy as well as to external stakeholders.

2. PROGRAM ASSUMPTIONS AND DATA QUALITY

As part of this project, EMI Consulting reviewed the technical assumptions that Xcel Energy has developed regarding costs, energy savings, and cost-effectiveness calculations. The purpose of this task was to help Xcel Energy ensure that the basis is sound for their measure-level assessments. In addition, we reviewed the sales data provided in the Xcel Energy ESRPP sales data portal to understand if the current state of the data quality allows for the type of analyses needed for the evaluation support work. Our review of the sales data involved identifying inconsistencies when matching product model numbers to bin, tier, program-qualified status, and other relevant characteristics.

The remainder of this chapter is organized into three main sections: (1) key findings, (2) a summary of our review of the product-specific technical assumptions, and (3) a summary of our review of the sales data from the sales data portal. Additional detailed findings are contained in Appendix A.

2.1 Key Findings from Technical Assumptions Review and Data Quality Review

EMI Consulting conducted its review of the technical assumptions using the information contained in a spreadsheet provided by Xcel Energy. The following are key findings from the technical assumptions review:

- There are two products for which the technical assumptions reference an out-of-date ENERGY STAR specification. For washers, the spreadsheet references V7.0 instead of V8.0; and for clothes dryers, the specification references V1.0 instead of V1.1. Other product categories reference up-to-date ENERGY STAR specifications.

- In some cases, assumptions are based on out-of-date sources. Where applicable, we provide more up-to-date suggestions for improving these assumptions.

- Assumptions for effective useful life (EUL) are generally sound (given they are based on ENERGY STAR data) and in-line with other ESRPP efforts.

- Assumptions for some other values, such as hours of use, could be made more precise by referencing the sources included in the footnotes in Appendix A. We also make specific recommendations for updates to parameters such as the number of loads per week for clothes washers.

Data for sales of models in ESRPP product categories are processed by ICF International for all ESRPP sponsors across the country. Each individual sponsor is then provided the data for their respective territory via an online sales portal. The following is the key finding from the sales data quality assessment:

- Overall, the quality of the data processing of sales data in the Xcel Energy ESRPP data portal is high. We do not see any major problems that would interfere with planned analyses or typical evaluation activities.

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In the following sections, we first provide a summary of the analysis of the technical assumptions worksheet. We then provide a summary of the data quality assessment. More detailed results from these two efforts are included in Appendix A and Appendix B, respectively.

2.2 Technical Assumptions Review

In the following sections we provide a high-level summary of our review of the specific assumptions included in the Xcel Energy assumption workbook.[7] The goal was to identify improvements Xcel Energy could make in its cost-effectiveness inputs.

For each spreadsheet tab we review the cost-effectiveness inputs, including inputs for energy savings calculations, as well as references. Based on our experience and professional judgment, when inputs or sources seemed unreasonable or out of date, we attempted to identify updated sources.

Product-Specific Assumptions Findings

On the whole, we found that the product-specific technical assumptions were generally sound and mirrored what other programs are using. In specific cases, we did recommend specific changes to these values based on more up-to-date research. In other cases, we recommended specific improvements based on multiple data sources to make these values more customized for Xcel Energy's residential customers. For instance, Xcel Energy's assumed value for clothes washer cycles per year was based on the 2005 Residential End Use Consumption Survey (RECS). This value is 295 cycles per year, or 5.67 loads/week, which is higher than the assumed value in the more recent version reviewed by EMI Consulting. From 2015 RECS data,[8] we estimated that between 65% and 70% of households with a clothes washer use it fewer than 4 times/week. By taking the entire distribution of usage for appropriate geographies into account, and utilizing the midpoint values of each range, we estimated the average weekly number of cycles to be 4.85 loads/week for Colorado and 3.54 loads/week for Minnesota.

More details on this review are provided in Appendix A.

General Findings (Non-Product-Specific)

In addition to reviewing product-specific assumptions, EMI Consulting also reviewed more general assumptions regarding future projections of program activity. Below we provide some of the general types of findings for non-product-specific tabs:

- In the "Electric Forecast Summary" tab, we did not see a source listed for the assumed NTG values. We noted that NTG values should be checked for accuracy.
- We noted that some of the hours of operation in the "Electric Forecast" summary tab should be cross-referenced with other tabs to ensure consistency.
- In some instances, EMI Consulting recommended that a different load profile be used for some product categories.

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[7] The Excel file provided to EMI Consulting was called "CO 19.PD.0 ENERGY STAR Retail Products Platform.xlsx"
[8] Available at: https://www.eia.gov/consumption/residential/data/2015/hc/php/hc3.8.php

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- EMI Consulting identified updated incremental measure cost estimates from PG&E's RPP Pilot workpaper.[9] PG&E's estimates are based on hedonic regressions of web-scraped price data. We recommend updating incremental measure cost values to these PG&E workpaper values as they are based on a more recent source that relied on large amounts of collected data.

2.3 Sales Data Review

The processing of ESRPP sales data is a complex task, as the data aggregator must combine data from dozens of stores across multiple retailers. The raw data from the retailers must be cleaned, and model numbers must be matched to ENERGY STAR-certified model numbers to determine if the model is qualified. This can be a difficult process, and in previous iterations of the data portal, EMI Consulting discovered inconsistencies in the data processing that could lead to erroneous results in the final analysis of sales data trends. The inclusion of the sales data review task as part of the Xcel Energy ESRPP Support work was motivated by the need to understand the accuracy of the data processing before conducting any type of quantitative analyses (e.g., regression modeling, Monte Carlo simulations). Overall, we found that the quality of the processed sales data is sufficiently high for EMI Consulting to conduct trend analyses. It is also possible to achieve even higher levels of accuracy by making manual corrections to the data, should higher levels of accuracy be required. We summarize each of the data quality checks below.

Summary of Data Quality Checks

EMI Consulting performed a number of specific QA/QC checks using portal data from May 2018. These checks included the following:

- Overall Consistency Check: For this check, we looked at each model to see how many different match statuses (i.e., whether or not a model was matched to a known data source), reviewed statuses (i.e., whether or not a model was reviewed to ensure it actually belongs in the product category to which it has been assigned), or bin assignments (i.e., the product subcategory) a model is given *over time*. In theory, any given model should only have one match status, one reviewed status, and one bin assignment.

- 'Ever Qualified' Status Check: For this check we determined if a particular model was ever program-qualified, which is important to know for analysis purposes.[10] The variable "ever qualified" indicates whether or not a model has *ever* been qualified, even if it became non-qualified at some point during the program (for instance, because program requirements shifted).

- Bin Assignment Check: For this check we reviewed how many of the program-qualified models were assigned to a bin. For most product categories, models are assigned to a specific bin based on characteristics of that model (for instance, its size). Assigning models to the correct bin may be important when conducting analyses at the bin level or calculating weighted unit energy savings.

Detailed results for these checks are included in Appendix B.

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[9] Available at http://deeresources.net/workpapers, Workpaper ID: PGECOAPP128.
[10] As program requirements or ENERGY STAR specifications change, some models that once were qualified will become non-qualified. It is important to make sure that this is captured when analyzing program-qualified market share over time.

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3. BASELINE DEVELOPMENT

ESRPP works to try to increase sales of energy-efficient appliances through existing market channels without a direct connection to the end-use customer. This means that there is no clear distinction between individual appliances purchased "through the program" and appliances purchased "outside the program," as there would be with a traditional down-stream program. Instead, by participating in the ESRPP program, Xcel Energy gains access to confidential sales data aggregated up from participating retailers indicating monthly sales by individual models. The achievements of the program are then the increase in sales observed during the program compared to what would have been sold without the program. These baseline sales are not observable and must therefore be estimated.[11] This section describes the method EMI Consulting used to estimate baseline sales and presents our findings.

3.1 Description of Methods

In order to identify baselines that best represent each product's pre-program period (prior to their incorporation into the ESRPP program), EMI Consulting modeled sales data during every possible combination of 12-months available for each product in the data provided by Xcel Energy.[12] We then selected the 12-month baseline that best fit the entire pre-program period and used the market model for that baseline period to predict sales quantities into the future to define the baseline. The remainder of this section describes this process in more detail.

The baseline market model for each 12-month period is based on a combination of three regression models, each reflecting different elements of the market dynamics. These regression models rely on the normalized sales values and market shares for each product group. We normalized the sales values by adjusting monthly sales values within a product group and tier, based on observed seasonal variation throughout the year, so that monthly sales values were more similar in quantity. This improved statistical model fit and enabled us to better distinguish between underlying seasonal trends and trends due to market changes.

We used these normalized sales data from each of the 12-month periods to define a model of market sales. Each of these models is evaluated on the pre-program sales data and allows for "naturally occurring" pre-program trends in sales or market share.

- **Sales Model:** This model uses monthly sales values, assuming that the effect of the program is to increase the sales of program-qualified products. This model explicitly allows qualified and non-qualified sales to vary separately.
- **Market Share Model:** This model uses monthly penetration rates, assuming that changes in market share are roughly constant. This model combines the qualified and non-qualified model sales and relies on changes in the ratio over time.
- **Probit Model:** This model uses a transformation of market share used in the Market Share Model. It is based on the assumption that changes in market share would be smaller in

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[11] These baseline sales, meaning the sales that would have occurred without the program, represent a counterfactual scenario.
[12] For example, the data portal contained 15 months of sales data for air cleaners in Colorado before program launch: March 2015 through May 2016. This means there are 4 possible baseline periods: March 2015 through February 2016, April 2015 through March 2016, May 2015 through April 2016, and June 2015 through May 2016.

absolute value if market share is extreme (either very small or very large), but larger if the market share is modest.

For each of these three models, we also selected between a regression that included a trend or only a constant value to match the pre-program market dynamics, based on model prediction fit. We then combined the three models into a single model for each baseline period and used each baseline model to predict values for the entire pre-program period, both within the individual baseline period and in the other years of the pre-program period.

We selected a baseline for each product that provided the best prediction fit to all the months in the pre-program period. Predicting these numbers in the baseline period allowed the evaluation team to calculate the best out-of-sample model fit, by comparing actual sales to the predicted sales. This provided the model with the best fit to the overall behavior, without being sensitive to individual observations.

Using these baseline models for each product group, tier, and state, we then created baseline sales forecasts by forecasting the baseline into the future. The Market Share Model and the Probit Model, relied on the forecasted values for total sales to be converted into sales values. The result is a series of monthly forecasted values, which we summed up by year to provide annual sales values.

3.2 Results

The methods described above in Section 3.1 provided annual sales values for each product group in both the Basic and Advanced tiers (if applicable), in both Minnesota and Colorado through 2025. These values are most likely to be valid within the first years of the program, though forecasting is less reliable in the long-term. The baselines presented here represent baselines based on the current market conditions during the time period leading up to the launch Xcel Energy's ESRPP. Because of that, they do not reflect any additional adjustments for relevant external conditions that will change in the coming years. As such, they provide a good estimate of what the baseline is over the short-run, but the validity of the baseline decreases as time goes on. Therefore, these baselines should be revisited in the future to make adjustments for changes in external conditions, such as changes in standards, changes in qualification tiers, changes in the macro economy, or technological developments. Adjustments could be made in line with the methods used for baseline adjustment by the Northwest Energy Efficiency Alliance's procedures for its ESRPP program.

This section provides results for 2017-2020. Complete results through 2025 are contained in Appendix C. Note that in some product categories, the baseline value is zero. This occurred in cases where no pre-program sales were observed, such as advanced room air conditioners, as well as in cases where the values were small and had a negative trend, such as freezers in the later years of the forecast.

Table 3-1 shows the baseline sales for Colorado. The forecast shows steady growth for basic and advanced air cleaners, basic air conditioners, basic dehumidifiers, and basic refrigerators, and rapid growth for basic and advanced dryers, advanced refrigerators, basic and advanced sound bars, and advanced washers. advanced air conditioners and advanced dehumidifiers have a constant forecast of zero sales, and basic and advanced freezers and basic washers have declining forecasts.

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Table 3-1. Colorado Baseline Sales 2017-2020

Tier	Year	Air Cleaners	Air Conditioners	Dehumidifiers	Dryers	Freezers	Refrigerators	Sound Bars	Washers
Basic	2017	2,597	1,640	41	22,526	334	30,364	185	4,319
	2018	2,709	1,794	58	31,232	196	34,525	263	1,823
	2019	2,807	1,953	73	40,419	83	38,734	374	664
	2020	2,900	2,102	76	48,871	5	42,565	520	51
Advanced	2017	897	-	-	157	123	3,402	998	15,438
	2018	1,011	-	-	341	59	4,324	1,317	23,002
	2019	1,122	-	-	722	21	5,337	1,692	29,384
	2020	1,225	-	-	1,408	1	6,349	2,097	35,009

Table 3-2 shows the baseline sales for Minnesota. The forecast shows steady growth for basic air cleaners, basic dehumidifiers, basic dryers, and basic and advanced refrigerators, and rapid growth for advanced air cleaners, advanced dryers, basic sound bars, and advanced washers. Basic air conditioners have a roughly constant forecast; advanced air conditioners and advanced dehumidifiers have a constant forecast of zero sales; and basic and advanced freezers, advanced sound bars, and basic washers have declining forecasts.

Table 3-2. Minnesota Baseline Sales 2017-2020

Tier	Year	Air Cleaners	Air Conditioners	Dehumidifiers	Dryers	Freezers	Refrigerators	Sound Bars	Washers
Basic	2017	1,881	1,132	178	14,025	25	23,319	147	3,514
Basic	2018	1,937	928	216	18,954	3	25,136	222	2,365
Basic	2019	1,979	928	258	21,762	0	26,235	324	2,234
Basic	2020	2,005	928	302	23,723	0	27,130	445	2,170
Advanced	2017	671	-	-	69	43	3,977	321	15,009
Advanced	2018	785	-	-	110	1	4,595	324	21,986
Advanced	2019	907	-	-	159	0	5,064	307	28,155
Advanced	2020	1,026	-	-	227	0	5,463	272	33,680

These baseline sales data represent an estimate of what sales would be in the absence of the ESRPP program. As such, sales above these baselines constitute net sales and should be adjusted further for net savings.

4. ASSESSMENT OF COST-EFFECTIVENESS POTENTIAL

An assessment of the prospects for cost-effectiveness of each product group provides Xcel Energy with key information to inform decisions about how to administer ESRPP. Specifically, it informs choices around which product groups to support through ESRPP, as well as which product groups may provide more benefits in the long-term, though they may struggle in the short term. To help Xcel Energy understand these prospects, EMI Consulting conducted a Monte Carlo simulation of cost-effectiveness for each product group and tier in each state. This Monte Carlo simulation generates thousands of scenarios across the product groupings to understand not only whether a product group and tier are likely to be cost-effective, but also to understand the relative risk of being non-cost-effective under groups of scenarios and the overall spread of the outcomes. This chapter first describes our methods for conducting the Monte Carlo simulation, followed by a high-level discussion of results and interpretation. EMI Consulting has also developed a software tool to allow Xcel Energy to conduct more in-depth scenario analyses beyond the high-level results presented here.

4.1   Description of Methods

Conducting the Monte Carlo simulation involved two primary activities: replicating Xcel Energy's cost-effectiveness calculations and simulating market outcomes. We describe each of these activities in this section.

Cost-Effectiveness Calculations

In order to conduct the cost-effectiveness test, we replicated the Xcel Energy Excel-based tool as a tool using computer code in the R programming environment. Based on inputs from Xcel Energy in its cost-effectiveness tool and ESRPP program documentation, the EMI Consulting tool implements two commonly-used cost-effectiveness tests: the Utility Cost Test (UCT) and the Total Resource Cost Test, modified for social costs (mTRC).[13]

Our tool replicates the Xcel Energy cost-effectiveness tool by calculating relevant streams of costs and benefits for the various products while allowing for Monte Carlo simulation. It relies on product group, sales quantity, qualification tier, and program state to identify the appropriate energy savings, peak reductions, transmission loss factors, winter and summer kWh charge rates, electric non-energy benefits adders, load shapes for each measure, incremental cost for each measure, rebate level for each measure, coincidence factor for each measure, installation rate for each measure, and realization rate for each measure. These are used to calculate streams of bill reductions, electric and gas system benefits, non-energy benefits, and environmental benefits. The tool then calculates the net present value of these value streams using the discount rates included in Xcel Energy's cost effectiveness tool. We also used per dollar kilowatt (kW) values, per dollar kilowatt hour (kWh) values, environmental externality per dollar kWh values, per dollar decatherm (Dth) values, and per dollar environmental externality values provided by Xcel Energy. The EMI Consulting tool then combines

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[13] We also ran the simulations using the Participant Cost Test (PCT), but after discussions with Xcel Energy staff decided to focus on the UCT and mTRC instead. All products in all cases were cost-effective under the PCT.

the relevant streams of costs and benefits for each test to calculate annual cost-benefit ratios and net benefits as well as the ratio of the net present value of costs and benefits. Finally, it calculates the net present value of the net benefits over a 12-year program horizon, or the effective useful life of the measure, whichever is shorter.

We tested our R-based tool by comparing its outputs to values from Xcel Energy's Excel-based tool and found that the cases we tested all agreed within +/-5%, and that most agreed within +/-1-2%.

Market Simulation

The evaluation team used variation in the sales data, the measurement uncertainty in sales increase rates, and empirically-based scenarios of program effects over time to conduct the Monte Carlo simulation of the distribution of outcomes. Each iteration of the simulation had a well-defined set of program characteristics recommended by Xcel Energy, defining the change over time in the rebate quantity, the extent of the rebate pass through, the incremental measure cost, and the program administration cost.

Each simulation iteration also randomly drew a stream of sales values above the baseline. Each stream of sales values included a fixed time for ESRPP to begin affecting product group sales rates, a high-increase or low-increase case, and the potential for ESRPP to have an increasing impact on program sales. These random draws were based on the observed changes in product sales above baseline estimated by EMI Consulting for Consolidated Edison's RPP program in New York.[14] That analysis found first-year increases in three product categories: freezers, refrigerators, and clothes washers, and an increase for room air conditioners that was not statistically significant. We used the observed mean and variance of the first-year estimates for the product groups with observed increases. For the other product groups, the evaluation found decreases that were not statistically significant. For these product groups, we used a truncated distribution using their estimated standard deviation and a mean of zero in the years before sales increases began, allowing the increase to be positive if the random draw was positive, and zero otherwise. In the time period when ESRPP has begun to influence sales, we drew from the distribution a high case, based on the observed increase for freezers, or a low case, based on the observed increase for room air conditioners. We then calculated the cost-effectiveness of each scenario, including both annual values and the current net present value using the cost-effectiveness tool described above.

By conducting many iterations of the simulation, EMI Consulting generated information about the distribution of cost-effectiveness that is likely to come from participation in ESRPP for each product group, qualification tier, and state. That is, rather than provide a single estimate of cost-effectiveness for each measure group, we are able to provide both an average estimate of cost-effectiveness for each measure group and information about how much uncertainty there is in that estimate based on the available information so that Xcel Energy can understand the range of outcomes and the riskiness of each product grouping. These results are discussed in the following section.

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[14] http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId=%7bF082B6D4-4D67-4C25-A86C-B71FBA2031D8%7d. Results used with permission from Con Edison.

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4.2 Results

This section provides the high-level results from the Monte Carlo simulations. In total, EMI Consulting conducted 1,027,584 individual iterations of the simulation across the two states and eight product categories. We present four sets of results here: overall results, a best-case scenario, a middle scenario, and a worst-case scenario. For each scenario we present the average test value, the average net benefits, and the percentage of scenarios that were not cost-effective under the utility cost test and the modified total resource cost test. Even in the worst-case scenario, all product groups were cost-effective under the participant cost test, so we do not include separate values in this section. It is important to remember when reviewing these results that the values are no predictions of what *will* happen. Rather, the purpose is to investigate the cost-effectiveness of ESRPP under a set of plausible scenarios to gain greater under understanding of the prospects for cost-effectiveness.

Table 4-1 provides the overall results of the simulation. That is, it includes all combinations of scenarios for sales increases and changes in program costs, including scenarios where some program costs remain at their current levels, some decline slowly, and some decline rapidly. Electric clothes dryers and basic gas clothes dryers were cost-effective in all simulations, while freezers and sound bars (in Minnesota only) were non-cost-effective in (almost) all simulations. Three cases provided a different verdict on average net benefits between the UCT and the modified TRC (mTRC): advanced gas clothes dryers in Colorado, advanced refrigerators in Minnesota, and advanced sound bars in Colorado. In each case the products performed better under the modified TRC.

Table 4-1. Overall Cost-Effectiveness Results

Product	State	Mean UCT Value	Mean UCT Net Benefits ($)	Share Non-Cost-Effective (UCT)	Mean mTRC Value	Mean mTRC Net Benefits ($)	Percent Non-Cost-Effective (mTRC)
Adv. Electric Clothes Dryers	CO	5.61	726,376	0%	1.88	1,039,510	0%
Adv. Electric Clothes Dryers	MN	3.64	215,916	0%	1.57	301,007	0%
Basic Electric Clothes Dryers	CO	17.80	1,865,579	0%	1.92	2,178,951	0%
Basic Electric Clothes Dryers	MN	12.20	691,479	0%	1.63	740,724	0%
Adv. Gas Clothes Dryers	CO	1.60	(65,685)	50%	1.15	175,704	15%
Adv. Gas Clothes Dryers	MN	1.71	18,799	42%	1.18	113,739	9%
Basic Gas Clothes Dryers	CO	6.82	584,705	0%	1.25	742,037	0%
Basic Gas Clothes Dryers	MN	7.71	404,509	0%	1.30	459,290	0%
Advanced Freezers	CO	0.10	(16,989)	100%	0.70	(4,838)	100%
Advanced Freezers	MN	0.09	(16,755)	100%	0.63	(6,992)	100%
Basic Freezers	CO	0.23	(8,663)	100%	0.67	(3,615)	99%
Basic Freezers	MN	0.16	(9,269)	100%	0.44	(6,923)	100%
Advanced Refrigerators	CO	1.63	21,221	50%	1.59	513,215	8%
Advanced Refrigerators	MN	1.36	(15,468)	50%	1.44	278,417	9%
Advanced Clothes Washer	CO	12.18	1,777,338	18%	5.73	2,336,483	18%
Advanced Clothes Washer	MN	9.99	1,292,320	18%	4.55	1,582,122	18%
Basic Clothes Washer	CO	17.12	835,907	18%	5.91	956,848	18%
Basic Clothes Washer	MN	14.83	681,224	18%	4.78	710,987	18%
Advanced Air Cleaners	CO	4.33	55,171	28%	2.73	65,193	26%
Advanced Air Cleaners	MN	3.22	33,043	33%	2.02	35,500	32%
Basic Air Cleaners	CO	4.40	69,682	26%	2.63	83,353	25%
Basic Air Cleaners	MN	3.03	37,139	33%	1.85	40,778	32%
Advanced Sound Bars	CO	0.65	(2,967)	79%	0.95	4,235	55%
Advanced Sound Bars	MN	0.18	(6,223)	100%	0.30	(4,776)	98%
Basic Sound Bars	CO	0.53	(3,273)	85%	0.72	(465)	69%
Basic Sound Bars	MN	0.22	(5,533)	99%	0.30	(4,643)	98%
Basic Room Air Conditioners	CO	5.76	60,895	5%	2.35	71,070	5%
Basic Room Air Conditioners	MN	2.43	16,689	23%	1.33	18,509	22%

Table 4-2 provides the results of the high-case scenarios. These scenarios involve high sales increases and rapid decreases in program costs. Specifically, program administration costs, incentive levels, incremental measure costs, and the portion of incentives retained by the retailer fall rapidly to near zero over the course of six years. Under these scenarios, all clothes dryers, refrigerators, and Colorado room air conditioners are cost-effective in all cases. Freezers and sound bars (in

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Minnesota) remain unlikely to be cost-effective, even under this best-case scenario. The UCT and modified TRC results aligned for all products by state and tier.

Table 4-2. High-Case Scenario Cost-Effectiveness Results

Product	State	Mean UCT Value	Mean UCT Net Benefits ($)	Share Non-Cost-Effective (UCT)	Mean mTRC Value	Mean mTRC Net Benefits ($)	Percent Non-Cost-Effective (mTRC)
Adv. Electric Clothes Dryers	CO	14.32	1,020,020	0%	4.18	1,174,887	0%
Adv. Electric Clothes Dryers	MN	8.21	313,651	0%	2.68	339,104	0%
Basic Electric Clothes Dryers	CO	44.14	1,947,702	0%	3.51	2,172,817	0%
Basic Electric Clothes Dryers	MN	27.27	751,902	0%	2.50	767,441	0%
Adv. Gas Clothes Dryers	CO	4.06	232,354	0%	1.64	292,555	0%
Adv. Gas Clothes Dryers	MN	3.87	127,286	0%	1.60	153,202	0%
Basic Gas Clothes Dryers	CO	16.66	725,005	0%	1.69	790,106	0%
Basic Gas Clothes Dryers	MN	17.22	461,873	0%	1.73	477,239	0%
Advanced Freezers	CO	0.15	(14,451)	100%	0.75	(3,580)	100%
Advanced Freezers	MN	0.11	(13,099)	100%	0.73	(3,694)	100%
Basic Freezers	CO	0.33	(6,429)	100%	0.75	(2,233)	97%
Basic Freezers	MN	0.21	(5,787)	100%	0.55	(3,605)	100%
Advanced Refrigerators	CO	3.47	479,225	0%	2.78	691,066	0%
Advanced Refrigerators	MN	2.63	265,289	0%	2.19	385,569	0%
Advanced Clothes Washer	CO	39.71	2,459,261	15%	28.31	2,812,359	15%
Advanced Clothes Washer	MN	31.72	1,622,408	15%	21.14	1,693,364	15%
Basic Clothes Washer	CO	38.28	914,720	17%	18.42	1,023,826	17%
Basic Clothes Washer	MN	35.31	874,692	9%	15.63	891,033	9%
Advanced Air Cleaners	CO	8.26	65,346	16%	5.44	74,080	16%
Advanced Air Cleaners	MN	6.31	44,533	19%	4.11	45,778	19%
Basic Air Cleaners	CO	9.28	99,851	19%	5.87	114,043	17%
Basic Air Cleaners	MN	5.49	48,036	20%	3.34	50,064	20%
Advanced Sound Bars	CO	1.33	4,678	37%	1.61	7,375	33%
Advanced Sound Bars	MN	0.29	(3,010)	98%	0.39	(2,333)	91%
Basic Sound Bars	CO	0.99	1,181	57%	1.16	2,272	50%
Basic Sound Bars	MN	0.37	(2,365)	93%	0.41	(2,060)	90%
Basic Room Air Conditioners	CO	10.96	72,216	0%	4.62	81,305	0%
Basic Room Air Conditioners	MN	3.89	21,577	11%	1.83	22,739	11%

Table 4-3 provides the middle-case scenario results. Under these scenarios, sales increases are modest and program costs decline at a modest rate. Specifically, program administration costs, incentive levels, incremental measure costs, and the portion of incentives retained by the retailer fall between five and ten percent each year. Most product groups appear to be cost-effective in the majority of cases, with the exception of freezers and sound bars. Two cases provided a different verdict on average net benefits between the UCT and the modified TRC: advanced and basic sound bars in Colorado. In both cases the products perform better under the modified TRC.

Table 4-3. Middle-Case Scenario Cost-Effectiveness Results

Product	State	Mean UCT Value	Mean UCT Net Benefits	Share Non-Cost-Effective (UCT)	Mean mTRC Value	Mean mTRC Net Benefits ($)	Percent Non-Cost-Effective (mTRC)
Adv. Electric Clothes Dryers	CO	8.04	828,692	0%	2.33	1,061,011	0%
Adv. Electric Clothes Dryers	MN	4.89	251,410	0%	1.79	306,597	0%
Basic Electric Clothes Dryers	CO	25.03	1,914,861	0%	2.32	2,186,952	0%
Basic Electric Clothes Dryers	MN	16.23	712,081	0%	1.85	744,232	0%
Adv. Gas Clothes Dryers	CO	2.30	35,269	50%	1.25	188,745	18%
Adv. Gas Clothes Dryers	MN	2.32	55,623	33%	1.27	117,827	6%
Basic Gas Clothes Dryers	CO	9.61	632,917	0%	1.36	746,038	0%
Basic Gas Clothes Dryers	MN	10.32	424,229	0%	1.41	460,393	0%
Advanced Freezers	CO	0.12	(16,005)	100%	0.72	(4,357)	100%
Advanced Freezers	MN	0.10	(15,529)	100%	0.67	(5,731)	100%
Basic Freezers	CO	0.27	(7,802)	100%	0.70	(3,102)	98%
Basic Freezers	MN	0.18	(7,984)	100%	0.48	(5,682)	100%
Advanced Refrigerators	CO	2.16	175,585	49%	1.85	532,531	1%
Advanced Refrigerators	MN	1.73	76,720	50%	1.60	290,359	6%
Advanced Clothes Washer	CO	19.75	1,973,775	16%	11.08	2,432,859	16%
Advanced Clothes Washer	MN	15.56	1,451,963	16%	8.26	1,642,699	16%
Basic Clothes Washer	CO	22.16	856,700	19%	8.83	970,473	19%
Basic Clothes Washer	MN	20.03	727,193	17%	7.09	750,749	17%
Advanced Air Cleaners	CO	5.41	59,212	24%	3.43	68,664	23%
Advanced Air Cleaners	MN	3.99	36,485	28%	2.52	38,410	28%
Basic Air Cleaners	CO	5.52	76,975	24%	3.30	90,249	23%
Basic Air Cleaners	MN	3.68	39,800	29%	2.21	42,677	29%
Advanced Sound Bars	CO	0.82	(241)	69%	1.10	4,992	51%
Advanced Sound Bars	MN	0.21	(5,138)	100%	0.32	(4,044)	97%
Basic Sound Bars	CO	0.65	(1,704)	77%	0.83	366	63%
Basic Sound Bars	MN	0.26	(4,478)	98%	0.33	(3,854)	96%
Basic Room Air Conditioners	CO	6.95	63,368	4%	2.85	72,815	4%
Basic Room Air Conditioners	MN	2.86	18,386	19%	1.47	19,912	18%

Table 4-4 provides the low-case scenario results. In these scenarios, sales increases are small, and program costs remain at their current levels. Specifically, program administration costs, incentive levels, incremental measure costs, and the portion of incentives retained by the retailer remain at the levels currently assumed by Xcel Energy. Under these scenarios, advanced gas dryers, all freezers, refrigerators, and all sound bars are non-cost effective in all iterations. All electric clothes dryers, and basic gas clothes dryers remain cost-effective. Five cases provided a different verdict on average net benefits between the UCT and the modified TRC: advanced gas dryers in Colorado and Minnesota, advanced refrigerators in Colorado and Minnesota, and advanced sound bars in Colorado. In all cases the products perform better under the modified TRC.

Table 4-4. Low-Case Scenario Cost-Effectiveness Results

Product	State	Mean UCT Value	Mean UCT Net Benefits	Share Non-Cost-Effective (UCT)	Mean mTRC Value	Mean mTRC Net Benefits ($)	Percent Non-Cost-Effective (mTRC)
Adv. Electric Clothes Dryers	CO	1.50	372,189	0%	1.32	1,225,604	0%
Adv. Electric Clothes Dryers	MN	1.35	95,628	0%	1.26	363,014	0%
Basic Electric Clothes Dryers	CO	5.51	1,687,804	0%	1.29	2,256,447	0%
Basic Electric Clothes Dryers	MN	4.86	623,101	0%	1.24	772,214	0%
Adv. Gas Clothes Dryers	CO	0.43	(431,617)	100%	1.07	318,225	0%
Adv. Gas Clothes Dryers	MN	0.62	(110,541)	100%	1.09	165,716	0%
Basic Gas Clothes Dryers	CO	2.09	411,435	0%	1.08	819,279	0%
Basic Gas Clothes Dryers	MN	3.00	336,536	0%	1.11	492,611	0%
Advanced Freezers	CO	0.07	(19,057)	100%	0.63	(5,957)	100%
Advanced Freezers	MN	0.07	(22,236)	100%	0.53	(11,705)	100%
Basic Freezers	CO	0.19	(11,373)	100%	0.62	(5,112)	100%
Basic Freezers	MN	0.10	(14,222)	100%	0.29	(11,928)	100%
Advanced Refrigerators	CO	0.57	(530,593)	100%	1.31	751,581	0%
Advanced Refrigerators	MN	0.56	(317,842)	100%	1.27	389,554	0%
Advanced Clothes Washer	CO	1.65	1,036,151	27%	1.64	1,995,340	27%
Advanced Clothes Washer	MN	1.65	921,832	17%	1.65	1,812,132	17%
Basic Clothes Washer	CO	7.14	832,526	21%	2.35	1,005,026	21%
Basic Clothes Washer	MN	5.87	536,241	23%	1.94	595,822	23%
Advanced Air Cleaners	CO	1.93	36,015	44%	1.40	47,499	42%
Advanced Air Cleaners	MN	1.84	26,907	39%	1.34	32,838	36%
Basic Air Cleaners	CO	2.09	48,987	39%	1.47	65,626	33%
Basic Air Cleaners	MN	1.59	26,021	44%	1.15	32,970	43%
Advanced Sound Bars	CO	0.34	(11,937)	100%	0.81	5,271	56%
Advanced Sound Bars	MN	0.12	(9,243)	100%	0.30	(6,265)	100%
Basic Sound Bars	CO	0.31	(8,152)	100%	0.62	(1,109)	66%
Basic Sound Bars	MN	0.13	(8,540)	100%	0.27	(6,427)	100%
Basic Room Air Conditioners	CO	3.41138764	59,153	9%	1.54	74,510	6%
Basic Room Air Conditioners	MN	1.4701255	11,477	40%	1.05	14,774	36%

4.3 Interpretation

The scenarios laid out above allow us to consider the relative risks associated with each product group under various circumstances. The high-case and the low-case scenarios help define some

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likely bounds on the risks and the rewards for each product scenario. If the benefits are not great under the high-case, it is unlikely that the product category will provide significant benefits. Conversely, if the cost-effectiveness is not low in the low-case, the product group is unlikely to pose a significant risk to the portfolio.

As mentioned above, all product groups appeared cost-effective under the participant cost test. This is likely because the incremental measure costs for the product groups are relatively modest, meaning that participant costs are low because of bill reductions due to energy efficiency. Even if the benefits are low, the net benefits remain positive. In the extreme case of sound bars, the incremental measure cost is zero and the participant cost test ratio is not well-defined.

Overall, the results are quite similar between the UCT and the modified TRC in terms of whether a product group is likely to be cost effective. In general, the average test values were closer to one under the modified TRC than under the UCT. That is, products groups were less likely to be highly cost-effective or highly non-cost-effective. There were only a small number of cases where the two tests gave different answers about whether a case was likely to have positive net benefits on average, which are discussed above.

Product-Level Results

In the remainder of this section, we briefly review the prospects for each product group.

Clothes Dryers:
- All electric clothes dryers and basic gas clothes dryers appear to present minimal risk to the program. Even under the low-case, they remain cost-effective. Under the high-case, they present an opportunity for significant net benefits.
- Advanced gas clothes dryers are much more dependent on the scenario. They are highly cost-effective under the high-case, and non-cost-effective under the low case. Under the low-case scenario, they appear to pose larger risks to overall program cost-effectiveness with negative net benefits in the hundreds of thousands of dollars. Advanced gas clothes dryers are more likely to be cost-effective under the modified TRC than under the UCT.

Freezers
- Freezers are non-cost-effective even under the high-case scenario. This is likely due to the fact that so few freezers have been sold in the pre-program period that baseline sales are low, and even large increases in sales volume do not present significant benefits.
- They also appear to present a low risk to the program as even under the low-case scenario they average net costs are in the $10,000 to $25,000 range.
- The low sales values in the baseline also present a significant possibility that sales could be higher than any of the scenarios included in this simulation, which would in-turn lead to significantly greater potential for cost-effectiveness.

Refrigerators
- Refrigerators are highly depending on the scenario. Under the high-case, they are highly cost-effective, under the low-case they are highly non-cost-effective. Due to the large volume of sales, they also present significant opportunity as well as significant risk.

- Advanced refrigerators perform much better under the modified TRC in the low-case scenarios, with positive average net benefits.

Clothes Washers
- Clothes washers appear to have a high likelihood of being cost-effective. Even under the low-case scenario, only 17-27% of cases were non-cost-effective and the average results presented significant net benefits.

Air Cleaners
- Air cleaners present a modest risk. Under the low-case scenario, they were non-cost-effective in 39-44% of cases, and provided positive net benefits on average.
- They also appear to present limited opportunity, with net benefits under $100,000 for each tier and state, even under the high-case scenario.

Sound Bars
- Sound bars appear to have a similar profile to freezers. In Minnesota they are unlikely to be cost-effective even under the high-case, with better prospects in Colorado. But they also appear to present low overall risk to the portfolio as net costs are relatively small even under the low-case.
- Sound bars are another product group that appears to perform better under the modified TRC than under the UCT.

Room Air Conditioners
- Room air conditioners vary significantly between states. They appear to present much better prospects in Colorado than in Minnesota.
- Even under the low-case, they are cost-effective, on average—even in Minnesota—and appear to be relatively low-risk of delivering significant net costs.

Overall, most product categories either have significant prospects for being cost-effective or limited risk of causing significant portfolio risk.

Comparison between States

In most of the cases we modeled the average results for Colorado are more cost-effective for Colorado than they are for Minnesota. Based on conversations with Xcel Energy staff this is not the typical outcome of a state-level comparison. We believe there are two primary reasons that results for Colorado are relatively better than results in Minnesota, as compared with other situations. In most analyses Colorado uses an NTG ratio that is less that one, but Minnesota uses a value of one. In the case of ESRPP we have analyzed the outcomes using an NTG of one for both states because the savings are based on increased sales over the baseline, so that a counter-factual is already taken into account. This puts the two states on a more even footing than usual. Then, the baseline sales in Colorado were higher than baseline sales in Minnesota, so the modeled sales impacts are greater, leading to greater benefits that balance against equivalent fixed program costs. This reasoning is supported by the fact that, although the average test values and net benefits are larger in most cases for Colorado than Minnesota, the share of simulations that are non-cost-effective is much more evenly split between the two states.

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5. LOGIC MODEL AND KEY PERFORMANCE INDICATORS

Working in parallel with the cost-effectiveness assessment, EMI Consulting worked with Xcel Energy to develop a simplified logic model and key performance indicators (KPIs) for program success. Based on this simplified Xcel Energy ESRPP logic model, EMI Consulting developed KPIs to help Xcel Energy understand how the program is operating and the ways in which it may be successfully transforming the market. In the following sections, we provide additional details on the development of the Xcel Energy-specific ESRPP logic model and the associated list of KPIs.

5.1 Logic Model

The purpose of this task was to provide Xcel Energy both with a deliverable for communicating with regulators and other stakeholders, and a way to track progress toward program success. EMI Consulting relied on experience developing logic models for other implementations of ESRPP, on the national-level logic model developed by SEE Action for ESRPP,[15] and on our current work with Xcel Energy to craft an Xcel Energy-specific logic model to facilitate understanding of how this program is run and to help satisfy regulatory needs. The final logic model is shown below in Figure 5-1.

A logic model represents program theory by showing how activities performed by the program translate into outputs, and then how these outputs are expected to lead to short-, mid-, and long-term outcomes. The Xcel Energy ESRPP logic model is designed to highlight the two most important aspects of the ESRPP program design:

- National scope: ESRPP is a nationally coordinated, mid-stream energy efficiency program. Program Sponsors across the United States strive for a consistent portfolio of qualifying products in home appliance and consumer electronics categories, and they coordinate implementation across regions.
- Mid-stream design: Per-unit incentives are paid to participating retailers, with the goal of influencing manufacturers. Collectively (across all the ESRPP sponsors), the scale of these incentives motivates retailers in a manner that would be impossible if only implemented by a single utility (these activities are captured in the logic model by Activities A1, A2, and A3 as well as their dependencies). Additional activities are aimed at directly influencing development of specifications, codes and standards (represented in the logic model as the pathway beginning with Activity A4).

In the following section we provide additional details on how program theory is represented by the simplified logic model.

Simplified Logic Model Detailed Description

The simplified logic model below shows that Xcel Energy performs four key activities:

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[15] This logic model is provided in Chapter 1.

- Xcel Energy provides per-unit incentives for qualifying units to participating retailers (A1).
- At the same time, Xcel Energy conducts in-store visits to (1) monitor the placement of promotional signage and other marketing activities, and (2) collect shelf survey data to understand how assortment may be changing.
- Xcel Energy also participates in several activities coordinated through the national ESRPP collaborative, including recruitment of new retailers (A3) and participation in discussions around codes and standards advocacy and other topics (A4).

There are several direct outputs resulting from these activities:

- By paying incentives to the retailers and tracking these sales, the retailers receive incentives while Xcel Energy has access to sales data (O1).
- Through its in-store field visits, signage is placed on qualifying models in the store, and Xcel Energy additionally has data on the types and diversity of models being stocked by retailers (O2).
- National discussions around the recruitment of new retailers should lead to an increase in the number of these retailers (O3).
- By participating in national discussions around codes and standards advocacy, product selection, and tier definitions, Program Sponsors will develop documented input related to these efforts (O4).

In the short-term (1-2 years), the following outcomes are expected to occur:

- Sales of qualifying models at participating retailers should increase, leading to a corresponding increase in the proportion of program-qualified model share (out of all sales for a given product category) (S1). Secondarily, this will allow the program to "ratchet up" qualifying requirements over time.
- Participating retailers should begin to factor ESRPP incentives into their assortment and marketing decisions as sales of these model increase (S2).
- Because the ESRPP program operates across the country, including multiple sponsors in different regions will allow the program to achieve a scale that is sufficient to affect retailers at a national level (S3).

In the mid-term (3-6 years), the following outcome are expected to occur:

- As consumer demand increases, participating retailers increase their offering and marketing efforts related to qualifying models (M1).
- This will lead to participating retailers requesting more qualifying units and a greater assortment of qualifying models from manufacturers (M2).
- At the same time, it is expected that ENERGY STAR specification criteria will become more stringent as demand for energy-efficient models increases (M3).
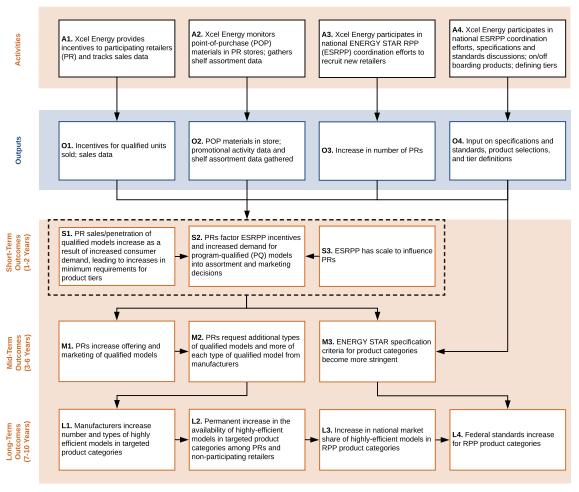
In the long-term (7-10 years), the following outcome are expected to occur:

- As retailers continue to request more qualifying models from manufacturers, manufacturers will respond by increasing production of these models (L1).

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- This will lead to a permanent increase in the availability of highly efficient models in ESRPP product categories, both among participating and non-participating retailers (L2).

- As manufacturers produce more highly-efficient models, we expect to see an overall increase in the national market share for these models (L3).

- Finally, it is expected that federal standards for ESRPP product categories will become more stringent, both as a result of increased demand for highly-efficient models as well as a result of codes and standards advocacy work (L4).

Figure 5-1. Simplified Xcel Energy ESRPP Logic Model

External Influences:
Broad economic conditions, market events, cost of energy, federal standards, ENERGY STAR, perceived need for conservation, and possible others.

Note: Factors can influence the program at all levels and time frames.

5.2 Key Performance Indicators

Based on the Xcel Energy-specific logic model described above, EMI Consulting developed KPIs to help Xcel Energy understand (1) how the program is performing, and (2) ways in which the program is successfully changing the market. These KPIs are related to program operations, outputs

produced by the program, and outcomes that Xcel Energy can measure in the market to indicate the extent to which there is evidence that retailer behavior is shifting due to the program intervention.

EMI Consulting produced three sets of KPIs: (1) a set of program performance indicators (PPIs) designed to assess current program functioning, (2) a set of market transformation indicators (MTIs) to understand how the program may be affecting market transformation, and (3) a set of secondary KPIs (including both PPIs and MTIs) that might be helpful, but not critical, in understanding program success. These sets of KPIs are detailed below in Table 5-1, Table 5-2, and Table 5-3.

KPIs 1 and 2 measure the direct output of the program. They reflect the scale of Xcel's ESRPP program. Larger values indicate a more successful implementation. KPIs 3 and 4 measure the oversite that the program is providing to participating retailers and indicates the extent to which field staff are engaging with retail staff to increase the impact of ESRPP. KPI 5 measures the changes observed in retailer behavior and the extent to which retailers are responding to ESRPP by increasing their in-store marketing of qualified models and, presumably, subsequently increasing sales of qualified models. KPIs 6 and 7 measure the extent to which ESRPP is driving changes in assortment and purchases. These are key mid- and long-term indicators of market transformation.

SKPI 1 through 7 are secondary key performance indicators. While they provide important information about the impacts of Xcel ESRPP, and should be tracked, we believe they are lower priority than the primary KPIs in the short term. SKPIs 1 through 4 provide auxiliary measures of the scope and scale of the program, including effort by Xcel Energy to increase that scope through recruitment of additional retailers. SKPIs 5 through 7 are measures of the impact of Xcel ESRPP on codes and standards. While this is a key element of the program logic, we believe that this is a lower priority to report in the short-term because the impacts are expected to occur over a longer period. Nonetheless, we believe it is important to track these indicators now to provide a data stream into the future, when these indicators will be of primary importance.

Table 5-1. Key Performance Indicators: Program Performance

ID	Type	Description	Data Source	Calculation	Level of Detail	Frequency	Logic Model Reference
KPI-1	PPI	Total deemed savings (kWh, kW, Dth)	ICF sales data	per-unit savings (kWh or kW or Dth) x total units sold	Overall and by product category	Monthly	A1/O1
KPI-2	PPI	Net benefit per program $ spent	Xcel Energy	$ total program spend per kWh or per kW saved	Overall	Quarterly and YOY	A1/O1
KPI-3	PPI	Number of store visits where POP materials are placed by Xcel Energy (by retailer)	Xcel Energy sub-contractor	# store visits with Xcel-placed POP	By retailer and product category	Quarterly and YOY	A2/O2
KPI-4	PPI	Number of store visits where Xcel field staff provide training to store employees	Xcel Energy sub-contractor	# store visits with trainings	By retailer	Quarterly and YOY	A2/O2
KPI-5	PPI	Number of store visits where ESRPP-related retailer-initiated promotional activity is detected	Xcel Energy sub-contractor	# store visits with retailer promotions detected	By retailer and product category	Quarterly and YOY	A2/O2

Table 5-2. Key Performance Indicators: Market Transformation

ID	Type	Description	Data Source	Calculation	Level of Detail	Frequency	Logic Model Reference
KPI-6	MTI	Program-qualified sales share (PQS)	ICF sales data	sales of program-qualified units / total sales	By product category	Quarterly and YOY	S1
KPI-7	MTI	Program-qualified model assortment share	Xcel Energy subcontractor	# of unique PQ models / total # of unique models (from shelf assortment data)	By product category and retailer	Quarterly and YOY	S1

Table 5-3. Secondary Key Performance Indicators

ID	Type	Description	Data Source	Calculation	Level of Detail	Frequency	Logic Model Reference
SKPI-1	PPI	Number of product categories incented	Xcel Energy	count of number of product categories	Overall	Annually	A1/O1
SKPI-2	PPI	Total incentive dollars paid	Xcel Energy, ICF sales data	$ incentive amount	By retailer and product category	Quarterly and YOY	A1/O1
SKPI-3	PPI	Number of participating store locations	Xcel Energy	# unique store locations participating in Xcel Energy territory	By retailer	Quarterly or annually	A2/O2
SKPI-4	PPI	Documentation of Xcel Energy efforts to recruit new national or regional retailers	Xcel Energy	documentation of efforts (# of discussions or meetings attended)	Overall	Annually	A3/O3
SKPI-5	MTI	Number of increases in minimum requirements for Xcel ESRPP efficiency tiers	Xcel Energy	# of changes in tier requirements (i.e., ratcheting up)	By product category	Annually	S1
SKPI-6	MTI	Number of increases in ES spec criteria	ENERGY STAR, ESRPP	# of spec changes	Overall	Annually	M3
SKPI-7	MTI	Number of increases in codes/standards	DOE, ESRPP	# of codes & standards changes	Overall	Annually	L4

6. SUMMARY AND RECOMMENDATIONS

To support Xcel Energy's management of and decision-making for the ESRPP program, EMI Consulting conducted a number of support activities, leveraging the work already conducted by Xcel Energy to provide the greatest value where possible. As part of this project, EMI Consulting:

- Reviewed the program assumptions and performed a quality assurance review of the data portal.
- Developed baseline sales values for each product group, tier, and state.
- Conducted a Monte Carlo simulation to investigate the prospects for cost-effectiveness for each product group, product tier, and state.
- Developed a simplified logic model and key performance indicators for the program.

This section provides a summary of the findings for the assumptions review, the portal review, and the Monte Carlo simulation. The primary output of the other activities are specific deliverables: the annual baseline estimates, the logic model, and the key performance indicators. EMI Consulting is also providing Xcel Energy with an analysis tool and data set to perform additional scenario analyses with the outputs of the Monte Carlo simulation.

6.1 Summary of Findings

Overall, the majority of the program assumptions appear to be sound. We identified some assumptions that could be updated, particularly with respect to energy savings inputs. We found no significant problems with the sales data portal.

The results of the Monte Carlo analysis indicate that most of the product groups have significant prospects for being cost-effective. Only freezers and sound bars (in Minnesota) appear unlikely to provide net benefits under any scenario, and they appear to pose low-risk to the overall portfolio cost-effectiveness. Advanced gas clothes dryers and refrigerators appear to pose significant risk under the low-case scenarios (i.e., low sales increases, costs not decreasing), but also offer significant opportunities under the better cases. Electric clothes dryers and basic gas clothes dryers appear to pose little risk of being non-cost-effective.

6.2 Recommendations

Based on our analysis, we make the following recommendations:

Recommendation 1: **Consider claiming net savings based on the sales above the baseline levels determined by this research rather than applying a net-to-gross ratio.** In traditional resource acquisition designs it is important to adjust measure volume using a net-to-gross ratio to account for the actions that program participants would have taken in the absence of the program. In the case of ESRPP, there is no direct interface with end users — retailers are the true participants. Program impacts are the sales levels beyond what would have happened without the program, which is the baseline

determined in this research. Sales above the baseline (i.e., what would have happened in the absence of the program) should be considered net accomplishments by the program without making additional adjustments for net savings.

Recommendation 2:   **Consider adopting the updated program assumptions resulting from our review of the current technical assumptions.** While the current assumptions are sound in most cases, we provide information that would allow several of the assumptions to be updated with more recent values, thereby improving the overall cost-effectiveness estimates. These assumptions are detailed in Appendix A.

Recommendation 3:   **Consider both the potential benefits and the potential risks in determining which product groups to include in ESRPP.** None of the product groups with poor prospects for being cost-effective appear to pose significant risk to the *overall* cost-effectiveness of the portfolio. On the other hand, some product groups offer greater potential for significant net benefits as well as significant net costs. Careful selection of product categories should enable Xcel Energy to appropriately balance portfolio risk and reward, and thereby ensure a more successful role in market transformation in Colorado and Minnesota.

Recommendation 4:   **Consider conducting an embedded evaluation of ESRPP to support the transition from resource acquisition to market transformation.** Although ESRPP is currently being operated as resource acquisition by Xcel, the national ESRPP is designed to be a market transformation effort. As such, it is critical to set up a framework by which the market transformation effects of ESRPP can be tracked over time, especially monitoring activity to understand how ESRPP is meeting the goals of the logic model and key performance indicators. Conducting embedded evaluation would support the long-term success of ESRPP by helping monitor new developments in the market and gather necessary data in real time. This will facilitate successful implementation of ESRPP and a successful transition from resource acquisition to market transformation.

Xcel Energy
ENERGY STAR Retail Products Platform (RPP) Planning Support

November 12, 2018

APPENDIX

Presented To:

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APPENDIX A: TECHNICAL ASSUMPTIONS REVIEW: DETAILED RESULTS

In the following sections we provide a tab-by-tab summary of our review of the Xcel Energy RPP technical assumptions spreadsheet.[1] The goal was to identify improvements Xcel could make in its cost effectiveness inputs. We conducted our review of the technical assumption tab-by-tab through the spreadsheet. In that process we discovered that in the updated version of the spreadsheet many of the cells contained reference errors. After consulting with Xcel staff, we relied on an earlier version of the spreadsheet without reference errors for those spreadsheet tabs.

For each spreadsheet tab we review the cost effectiveness inputs, including inputs for energy savings calculations, as well as references. Based on our experience and professional judgment, when inputs or sources seemed unreasonable or out of date, we attempted to identify updated sources.

Product-Specific Assumptions Findings

In the following sections we provide a brief assessment of the product-specific tabs, noting where we questioned the assumed values or observed deficient documentation.

Air Cleaners

- The source of the data supporting the calculations of the weighted average for baseline estimates should be documented more clearly.
- The hours of use (5,840), or 16 hours/day 365 days per year, comes from ENERGY STAR standard calculations. This value is used frequently (for instance, it is referenced in the New York State Technical Reference Manual),[2] though it is higher than some other sources. For example, EMI Consulting has conducted research in California leading to a value of 3,641 hours/year.
- The assumed measure life (9 years) is based on a 2008 document. This value is cited in both the New York and Massachusetts State Technical Reference Manuals, as well as the California Database of Energy Efficiency Resources, all three of which reference the EPA Calculator assumptions that were last updated in October 2016.

Clothes Dryers [3]

- The number of cycles per year shown in the "Energy Consumption" box is 283, but the "Operating Hours Derivation" in row 24 uses a value of 232. We recommend clarifying why these are different.

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[1] The Excel file provided to EMI Consulting was called "CO 19.PD.0 ENERGY STAR Retail Products Platform.xlsx"
[2] Available at:
http://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/72c23decff52920a85257f1100671bdd/$FILE/TRM%20Version%206%20-%20January%202019.pdf
[3] We did not review this tab in detail as it was still undergoing revisions at the time this memo was written.

Clothes Washers

- The assumed value for cycles per year is based on the 2005 Residential End Use Consumption Survey (RECS). This value is 295 cycles per year, or 5.67 loads/week, which is higher than the more recent version we reviewed. From 2015 RECS data,[4] we estimate that between 65% and 70% of households with a clothes washer use it fewer than 4 times/week. When we take the entire distribution of usage for appropriate geographies into account, and utilize the midpoint values of each range, we estimate the average weekly number of cycles to be 4.85 loads/week for Colorado and 3.54 loads/week for Minnesota.

Freezers

- As with other product categories, we note that the source for market share is old (2008).
- The spreadsheet includes equations and associated values that do not contain a source reference (a reference was provided by Xcel staff). But it is unclear how, if at all, these numbers enter the savings estimates, as those numbers are hard-coded.
- The assumed value for product lifetime is 12 years (based on ENERGY STAR), which is line with the value used in California (11 years).[5]

Room Air Conditioners

- The assumed value for hours of operation is 750 hours/year, which seems to be a reasonable value, though there is no source listed to document this.
- As with other categories, the market share data is slightly out of date (2008).

Refrigerators

- The AHAM shipment data is from 2012 and while we recommend using more recent values, this is a low priority task.
- The source of the equation for maximum energy use is unclear.
- The ENERGY STAR product lifetime value of 12 years (based on ENERGY STAR) is in line with, though slightly lower than, the value of 14 years used in California.[6]

Soundbars

- Our assumption is that the 8760 hours of operation for soundbars is combined with the duty cycle weights and mode power draws in the energy savings calculations, although this is somewhat unclear. This approach may cause problems combined with load profiles that include 100% coincidence factors as the on-peak mode distribution is likely different from the overall mode distribution throughout the year (e.g. soundbars are probably in off mode more often during the night than during the peak period).

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[4] Available at: https://www.eia.gov/consumption/residential/data/2015/hc/php/hc3.8.php

[5] California Public Utilities Commission, Database of Energy Efficiency Resources (DEER). Available: http://http://www.deeresources.com/

[6] Ibid.

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- The source for hours of operation for active/idle/sleep modes is old (2011).[7] If our assumption about the role of the duty cycle in the calculation and they play some other role, more up-to-date source uses the following values: [8]
    - active mode = 3.7 hours
    - idle mode = 5.5 hours
    - off = 14.8 hours
- We recommend clarifying how the assumed value of 8,760 hours of use is affected by the assumptions that a soundbar is in each mode (also see notes on "Electric Forecast Summary" below).
- The links for sources in this tab do not work.
- Xcel Energy uses a 2010 paper published by the Fraunhofer Center for Sustainable Energy System titled "Energy Consumption of Consumer Electronics in US Households." This study estimates a baseline consumption estimate of 77 kWh. The same authors and organization published a 2014 updated paper[9] which has a baseline of 82 kWh, then another 2017 update paper[10] which uses 65 kWh, see table 8-8). All three papers used phone survey methodologies. Given this spread, we recommend keeping the existing baseline value of 77 kWh.
- As the measure definition is based on ENERGY STAR +15%, for documentation purposes it would be helpful to see the ENERGY STAR value for comparison purposes.
- The additional references in the "Product Lifetime" box are potentially confusing. ENERGY STAR uses 7 years, but values from other sources are listed here as well. If the concept is that sound bars would be replaced when these other devices ones are replaced, this should be made clear. If not, we suggest moving the years for other electronics into a footnote or similar for reference purpose only. The current value used in California is 4 years.[11]

General Findings (Non-Product-Specific)

In the following sections we provide a brief assessment of the synthesis tabs that bring together the product-specific assumptions, noting where we questioned the assumed values or observed deficient documentation.

TA Templates

- Sources for annual hours of operation/use are not all clearly documented, though overall these values appear reasonable. It is our understanding that some of these values from

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[7] Available at: http://www.energy.ca.gov/appliances/2013rulemaking/documents/responses/Consumer_Electronics_12-AAER-2A/California_IOUs_Response_to_the_Invitation_to_Participate_for_Displays_REFERENCES/Fraunhofer_2011_Energy_Consumtions_of_Consumer_Electronics_in_U.S._Homes.pdf

[8] Available at: https://www.cse.fraunhofer.org/hubfs/CTA%20Energy-Consumption-of-Consumer-Electronics-in-U-S-Homes-in-2017.pdf

[9] Available at: https://www.cta.tech/CTA/media/policyImages/Energy-Consumption-of-Consumer-Electronics.pdf

[10] Available at: https://www.cse.fraunhofer.org/hubfs/CTA%20Energy-Consumption-of-Consumer-Electronics-in-U-S-Homes-in-2017.pdf

[11] California Public Utilities Commission, Database of Energy Efficiency Resources (DEER). Available at: http://http://www.deeresources.com/

ENERGY STAR savings calculations, while others are pulled from existing Xcel Energy programs.

- As noted above, soundbars assume 8,760 annual hours of operation despite the duty cycle listed in the measure sheet, which indicates different modes of operation, and it is unclear how this duty cycle is used in building up the overall profile.
- It appears that the same hours of operation are being used for both the pre- and post- for each product category. For some product categories, such as sound bars, the efficient models may operate for fewer hours than the inefficient models. Similarly, size differences for clothes washers may lead to differences in hours of operation between efficient and inefficient models. These differences may be too small to worry about, and we have not identified data sources indicating these differences.
- The coincidence factor (CF) for sound bars and freezers could be adjusted:
  - The CF for sound bars is assumed to be 100%, which is high (see notes in the section on soundbars above).
  - The CF for freezers is assumed to be 55%, which may be too low.
- The specified lifetime for refrigerators in the "TA Templates" tab is 18 years, but in the "refrigerators" tab it is 12 years. As the value of 18 years was approved for use in Xcel Energy's other home efficiency programs, we recommend stating this approval and removing the ENERGY STAR reference, thereby making the values consistent.

Electric Forecast Summary

- We did not see a source listed for the assumed NTG values. While we understand Xcel Energy assumes a NTG of 1.0 for new products, we note that column AE contains values other than 1.0. Some of these values are as low as 20%, which will likely have an impact on final results. These values are being use in the calculation of net kW and net kWh. The older excel file we reviewed (ESRPP TAs shared 050218) has all NTG values set to 100%.
- Some of the hours of operation in the "Electric Forecast" summary tab do not match the "TA templates" tabs. For example, the assumed hours of operation for room ACs is 750 hours on the "TA templates" tab but only 662 in the "Electric Forecast" tab. We recommend making sure that these values are consistent in all sheets.
- We note that the measure load shape for soundbars B (SFFRZ) is different than soundbars A (SFCTV). A SFFRZ load shape tends to make more sense with the 8760 hours of operation, but the SFCTV shape seems more realistic for when people would actually be using sound bars.
- The same situation applies for freezers regarding different profiles for B and A. We would expect this profile to be fairly flat across the day, and would suggest that the SFFRZ load shape may be more appropriate than the SFSDH load profile.
- For air cleaners, it is sensible to apply the same load profile to both B and A, but the choice of load profile is unclear. We suggest using SFFRZ instead.
- For room ACs, the spreadsheet currently uses assumptions that lead to significant load savings in fall/winter, which seems implausible. Load profiles 34 or 35 may be more appropriate.
- For refrigerators, the current load profile matches dryers and washers, but a load profile matching freezers may be more appropriate.

RPP Scenario Tabs

- In general, the "RPP Scenario" tabs contain multiple reference errors that carry through to subsequent tabs.[12]

Incremental Measure Costs

EMI Consulting identified updated incremental measure cost estimates from PG&E's RPP Pilot workpaper.[13] PG&E's estimates are based on hedonic regressions of web-scraped price data. That is, they developed an automated system to capture large amounts of information from retailer websites to build a database of prices. Then they estimate a pricing equation to estimate the marginal impact of a product being Energy Star Qualified. In this way it controls for other characteristics of qualified products that are correlated with being qualified. That is, Energy Star Qualified products are more likely to have other desirable features, so an average cost comparison between qualified and non-qualified products will capture price differences due to those other characteristics as well. The hedonic pricing models control for other characteristics to isolate the impact due to the increased efficiency only.

We recommend updating incremental measure cost values to these PG&E workpaper values as they are based on a more recent source that relied on large amounts of collected data. Current and recommended values for incremental measure costs are shown below in **Table 1**.

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[12] Because of the errors, we switched to reviewing the remaining tabs on the older version of the workbook "ESRPP TAs shared 050218."

[13] Available at http://deeresources.net/workpapers, Workpaper ID: PGECOAPP128.

Table 1. Current and Recommended Incremental Cost Values

Category	Current Value	Recommended Value	Notes
Soundbars B	$0	$0	
Soundbars A	$0	$0	
Freezers B	$10.11	$8.50	Average of chest freezer and upright freezer
Freezers A	$10.11	$8.50	Average of chest and upright freezers
Gas Clothes Dryers B	$27.02	$27.02	No data available
Gas Clothes Dryers A	$27.02	$27.02	No data available
Electric Clothes Dryers B	$206.00	$84.00	
Electric Clothes Dryers A	$206.00	$535.00	
Air Cleaners B	$56.00	$80.00	
Air Cleaners A	$56.00	$80.00	
Room Air Conditioners	$114.45	$22.00	
Refrigerators A	$50.00	$75.00	
Clothes Washers B	$50.00	$145.00	Combination of front- and top-loading clothes washers
Clothes Washers A	$50.00	$145.00	Combination of front- and top-loading clothes washers

As with Xcel's existing assumption, most products did not have separate estimates for basic and advanced qualified status. The exception was electric clothes dryers. In this case the advanced tier was estimated based on the pricing for Energy Star Most Efficient products with heat pumps. No data were available for gas clothes dryers and so we recommend no change for these products.

APPENDIX B: SALES DATA REVIEW: DETAILED RESULTS

The processing of RPP sales data is a complex task, as the data aggregator must combine data from dozens of stores across multiple retailers. The raw data from the retailers must be cleaned, and model numbers must be matched to ENERGY STAR-certified model numbers to determine if the model is qualified. This can be a difficult process, and in previous iterations of the data portal, EMI Consulting discovered inconsistencies in the data processing that could lead to erroneous results in the final analysis of sales data trends. The motivation for the sales data review task being conducted as part of the Xcel Energy RPP Support work was motivated by the need to understand the accuracy of the data processing before conducting any type of trend analyses (i.e., regression modeling, Monte Carlo simulations, etc.).

Overall, we found that the quality of the processed sales data is sufficiently high for EMI Consulting to conduct trend analyses. It is also possible to achieve even higher levels of accuracy by making manual corrections to the data, should higher levels of accuracy be required.

We summarize each of the data quality checks in more detail below.

Summary of Data Quality Checks

EMI Consulting performed a number of specific QA/QC checks using portal data from May 2018. These checks included:

- **Overall Consistency Check:** For this check, we look at each model to see how many different match statuses (i.e., whether or not a model was matched to a known data source), reviewed statuses (i.e., whether or not a model was reviewed to ensure it actually belongs in the product category to which it has been assigned), or bin assignments (i.e., the product subcategory) a model is given *over time*. In theory, any given model should only have one match status, one reviewed status, and one bin assignment.

- **'Ever Qualified' Status Check:** For analysis purposes, it is important to know if a specific model has ever been program-qualified. The variable "ever qualified" indicates whether or not a model has *ever* been qualified, even if it became non-qualified at some point during the program (for instance, because program requirements shifted).

- **Bin Assignment Check:** For most product categories, models are assigned to a specific bin based on characteristics of that model (for instance, its size). Assigning models to the correct bin may be important when conducting analyses at the bin level or calculating weighted unit energy savings.

We summarize each of these checks below.

Internal Consistency of Model Information Over Time is High for All Product Categories

Table 2 shows that only a few models have identifiable inconsistencies in match status, reviewed status, or bin assignment *over time*. Freezers are the only product categories for which greater than 10% of total sales reflected some type of inconsistent processing (i.e., more than one match status, reviewed status, or bin assignment). In all cases, such inconsistencies are concentrated in a small number of models, and can be manually corrected if needed.

Table 2. Summary of Internal Consistency Check by Product Category

Product	Total Sales in Product Category	Models with Discrepancy [a]		
		Total Sales	Percent of Category Sales	Number of Distinct Models
Clothes Dryers	235,336	757	0.3%	9
Air Cleaners	18,088	564	3.1%	2
Air Conditioners	47,169	1,753	3.7%	8
Soundbars	152,457	7,206	4.7%	6
Washers	285,004	17,352	6.1%	23
Refrigerators	345,571	27,033	7.8%	65
Freezers	68,542	7,817	11.4%	9

[a] Inconsistency is defined as a given model having more than one match status, reviewed status, or bin assignment over time.

'Ever Qualified' Status Assignment is Satisfactory for All Product Categories

As of May 10th, 2018, **Table 3** shows that all product categories except freezers have achieved greater than 99% agreement (by sales volume) between the current "ever qualified" status in the portal and the "ever qualified" status determined by the QA/QC process. In most cases, the inconsistencies are contained within a relatively small number of unique models and should be relatively easy to correct manually if needed. (For instance, in the case of washers, inconsistencies were only detected in one model.)

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Table 3. Classification Accuracy by Product Category: "Ever Qualified" Status

Product	Total Sales in Product Category	Models with Questionable 'Ever Qualified' Status		
		Total Sales	Percent of Category Sales	Number of Distinct Models
Air Cleaners	18,088	-	-	-
Dehumidifiers	16,777	-	-	-
Freezers	68,542	-	-	-
Soundbars	152,457	-	-	-
Washers	285,004	6	<0.1%	1
Dryers	235,336	82	<0.1%	3
Air Conditioners	47,169	353	0.7%	1
Refrigerators	345,571	2639	0.8%	21

Note: A '-' indicates no discrepancies were discovered for a product category.

Bin Assignment Coverage is Satisfactory for All Product Categories

As part of the classification accuracy check, we also examined the extent to which models in each product category are assigned to a bin (shown in **Table 4**). Binning is required for all product categories except soundbars (which has no bins). Having a high percentage of models assigned to a bin can be important when conducting sales data analyses. Incorrect or inconsistent assignment to a bin is also an indicator of problematic data processing.

Results show that clothes dryers, freezers, clothes washers, and air conditioners have all achieved >95% of total sales being assigned to a bin. Air cleaners and refrigerators have achieved >90% bin assignment coverage. We believe that this level of bin assignment coverage is acceptable for analyses being conducted as part of this project.

Table 4. Percentage of Sales Assigned to a Bin by Product Category

Product	Total Sales in Product Category	Models Not Assigned to a Bin		
		Total Sales	Percent of Category Sales	Number of Distinct Models
Clothes Dryers	235,336	2,011	0.9%	127
Freezers	68,542	972	1.4%	56
Washers	285,004	7,965	2.8%	236
Air Conditioners	47,169	1,845	3.9%	55
Air Cleaners	18,088	1,073	5.9%	66
Refrigerators	345,571	23,911	6.9%	708
Dehumidifiers	16,777	N/A	N/A	N/A
Soundbars	152,457	N/A	N/A	N/A

Note: Dehumidifiers and soundbars have only one bin.

APPENDIX C: BASELINE DETERMINATION: DETAILED RESULTS

This appendix presents the full baseline sales estimates for Xcel Energy ESRPP from 2017 through 2025. Results for 2017 through 2020 were presented in Chapter 3 of this report.

Table 5. Colorado Baseline Sales 2017-2025

Tier	Year	Air Cleaners	Air Conditioners	Dehumidifiers	Dryers	Freezers	Refrigerators	Soundbars	Washers
Basic	2017	2,597	1,640	41	22,526	334	30,364	185	4,319
	2018	2,709	1,794	58	31,232	196	34,525	263	1,823
	2019	2,807	1,953	73	40,419	83	38,734	374	664
	2020	2,900	2,102	76	48,871	5	42,565	520	51
	2021	2,992	2,252	76	56,447	-	45,544	716	-
	2022	3,084	2,402	76	61,266	-	48,278	970	-
	2023	3,176	2,545	76	65,057	-	50,950	1,293	-
	2024	3,273	2,581	76	68,549	-	53,717	1,717	-
	2025	3,368	2,581	76	71,094	-	56,310	2,206	-
Advanced	2017	897	-	-	157	123	3,402	998	15,438
	2018	1,011	-	-	341	59	4,324	1,317	23,002
	2019	1,122	-	-	722	21	5,337	1,692	29,384
	2020	1,225	-	-	1,408	1	6,349	2,097	35,009
	2021	1,326	-	-	2,544	-	7,319	2,551	40,427
	2022	1,426	-	-	4,180	-	8,326	3,056	45,351
	2023	1,525	-	-	6,217	-	9,398	3,613	48,394
	2024	1,629	-	-	8,583	-	10,606	4,260	50,902
	2025	1,728	-	-	10,805	-	11,834	4,933	52,001

Table 6. Minnesota Baseline Sales 2017-2025

Tier	Year	Air Cleaners	Air Conditioners	Dehumidifiers	Dryers	Freezers	Refrigerators	Soundbars	Washers
Basic	2017	1,881	1,132	178	14,025	25	23,319	147	3,514
	2018	1,937	928	216	18,954	3	25,136	222	2,365
	2019	1,979	928	258	21,762	0	26,235	324	2,234
	2020	2,005	928	302	23,723	0	27,130	445	2,170
	2021	2,018	928	349	25,284	0	27,888	539	1,895
	2022	2,018	928	400	25,950	0	28,517	632	1,639
	2023	2,005	928	454	25,866	0	29,028	730	1,445
	2024	1,980	928	505	25,635	0	29,451	839	1,283
	2025	1,945	928	524	25,327	0	29,755	948	1,158
Advanced	2017	671	-	-	69	43	3,977	321	15,009
	2018	785	-	-	110	1	4,595	324	21,986
	2019	907	-	-	159	0	5,064	307	28,155
	2020	1,026	-	-	227	0	5,463	272	33,680
	2021	1,147	-	-	327	0	5,822	269	37,192
	2022	1,268	-	-	469	0	6,141	274	39,937
	2023	1,389	-	-	663	0	6,419	278	42,381
	2024	1,515	-	-	933	0	6,670	284	44,670
	2025	1,633	-	-	1,252	0	6,868	292	46,530